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(54) **A curable fluoroelastomer composition.**

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EP 0 182 299 B1

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DescriptionBackground of the Invention

5 This invention relates to a vinylidene fluoride elastomer composition containing a specific iminium compound as an accelerator.

10 Cured vinylidene fluoride elastomers (fluoro rubber) have been used for various purposes such as O-rings, gaskets, diaphragms, hoses, sheets, rools and the like, and demand for these elastomers has recently increased more and more.

15 There have been proposed hitherto many kinds of vinylidene fluoride elastomer compositions containing a polyhydroxy aromatic compound as a curing or cross-linking agent to improve compression set and scorch resistance properties. The improvement of these properties has been studied mainly from the view point of development of a curing accelerator to be used together with the polyhydroxy aromatic compound being a curing agent. For example, U.S. Patents 3,655,727 and 3,876,654 teach the use of a quaternary phosphonium compound as a curing accelerator. U.S. Patent 3,655,727 also teaches the quaternary ammonium compound. The specific quaternary ammonium compound of 8-alkyl- or 8-aralkyl-1,8-diaza-bicyclo[5.4.0]-7-undecenium and the amino phosphinic derivatives are disclosed in U.S. Patents 3,857,807 and 4,259,463, respectively. In addition, the Bis(triarylphosphin)iminium compound was recently reported in European Patent Application No. 841031 26.3 (EPO 0120462 A1).

20 However, the values of compression set, especially at high temperatures, of the rubbers obtained from these fluoroelastomer compositions do not reach adequately satisfactory levels. Further, when the rate of curing is retarded by a reduction in the amount of the curing accelerator in order to prepare complicated or thick-gage articles, adhesion of the cured elastomer to a mold occurs which induces the appearance of defects in the articles and contamination of the mold.

25 In the case of a composition employing the quaternary ammonium compound, in addition to the above problems, there are some other problems, which are induced by hygroscopic and deliquescent properties. These problems include the necessity of the troublesome consideration for safety storage of the composition and a decrease in the curing property as well as various properties of the obtained cured elastomer.

30 In the case of the Bis(triarylphosphin)iminium compound, as shown in EXAMPLES hereinafter, the cured elastomer obtained shows higher compression set, especially at higher temperature, low elongation and large variations of strain property in the thermal aging test.

Summary of the Invention

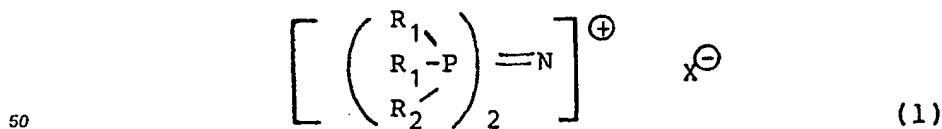
35 The object of the present invention is to provide a vinylidene fluoride elastomer composition having excellent characteristics regarding curing properties processability, storability and mold releasing as well as compression set without losing the good thermal, oil and chemical resistance shown by the conventional compositions.

40 The present invention is directed to a curable fluoroelastomer composition comprising

(a) 100 parts by weight of a fluoroelastomeric copolymer of vinylidene fluoride and at least one other fluorinated monomer,

(b) 0.05 to 2.0 parts by weight of a curing accelerator comprising an iminium compound represented by the general formula (1);

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55 wherein R_1 is an aryl group or a substituted aryl group substituted by at least one group selected from an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, a cycloalkyl group having 3 to 8 carbon atoms, a cyano group, a group of the formula



5 (wherein R₃ and R₄, the same or different, are C₁-C₂₀ alkyl groups, C₃-C₈ cycloalkyl groups or phenyl groups) and a halogen atom,
 R₂ is an alkyl or halogenated alkyl group having 1 to 20 carbon atoms, a cycloalkyl or halogenated cycloalkyl group having 3 to 8 carbon atoms, an aralkyl group having 7 to 20 carbon atoms, or a substituted aralkyl group having an aralkyl skeleton of 7 to 20 carbon atoms in which at least one hydrogen atom of the aryl part is substituted by at least one member selected from a C₁-C₂₀ alkyl group, a C₃-C₈ cycloalkyl group, a C₁-C₂₀ alkoxy group, a phenyl group, a cyanogroup, a group of the formula



(wherein R₃ and R₄, the same or different, are C₁-C₂₀ alkyl, C₃-C₈ cycloalkyl or phenyl groups) and a halogen atom
 20 X is halogen, hydroxyl, sulfate, thiosulfate, nitrate, formate, acetate, cyanate, thiocyanate, tetraphenylborate, 2-mercaptopbenzothiazolate, or perchlorate ion,
 (c) 0.1 to 10 parts by weight of a polyhydroxy compound as a cross-linking agent, and
 (d) 1 to 30 parts by weight of a metal compound selected from a divalent metal hydroxide, a divalent metal oxide or a mixture thereof.

25

Description of Preferred Embodiment

As illustrated above, the primary characteristic point of the present invention resides in that the special 30 iminium compound (b) represented by the general formula (1) is employed as a curing accelerator. The cured elastomer of the present invention is more excellent in compression set, elongation and strain properties than the cured elastomer obtained from a Bis(triarylphosphine)iminum compound.

Among the iminium compounds (b) shown by the formula (1), preferred compounds have an unsubstituted or substituted phenyl group as R₁. An unsubstituted phenyl group is more preferable. A more 35 preferable substituent of the substituted phenyl group among the substituents described above, is an alkyl or alkoxy group having 1 to 4 carbon atoms.

Preferable groups of R₂ are an alkyl group having 1 to 20 carbon atoms, more preferably 1 to 10 carbon atoms, a cycloalkyl group having 3 to 8 carbon atoms, more preferably 3 to 6 carbon atoms, an aralkyl group having 7 to 20 carbon atoms and a substituted aralkyl group having a C₇-C₂₀ aralkyl skeleton. 40 Preferable substituents of the substituted aralkyl group are an alkyl or alkoxy group having 1 to 4 carbon atoms, a phenyl group and halogen which are bonded to a phenyl part of the aralkyl group. A benzyl group is the most preferable group.

In the general formula (1), as will be understood by a person skilled in the art, the charge of X is not limited to mono valence, and therefore, means mono and poly valence.

45 Representative compounds (b) are described hereinafter in accordance with each of the preferable groups of R₁ and R₂.

(1) Bis(methyldiphenylphosphine)iminum chloride and tetraphenylborate, Bis[methyldi(4-methylphenyl)-phosphine]-iminum chloride, Bis[methyldi(4-butylphenyl)phosphine]-iminum chloride, Bis-(butyldiphenylphosphine)iminum bromide, Bis(dodecyldiphenylphosphine)iminum chloride, Bis-(tetradecyldiphenylphosphine)iminum chloride, Bis-(hexadecyldiphenylphosphine)iminum chloride and Bis-(octadecyldiphenylphosphine)iminum chloride.
 50 (2) Bis[methyldi(4-methoxyphenyl)phosphine]iminum chloride.
 (3) Bis(cyclohexyldiphenylphosphine)iminum chloride.
 (4) Bis[benzyldiphenylphosphine]iminum chloride, bromide and acetate, Bis[benzyldi(4-methylphenyl)-phosphine]iminum chloride, Bis(2-methylbenzyldiphenylphosphine)iminum chloride, Bis(3-methylbenzyldiphenylphosphine)iminum chloride, Bis(4-methylbenzyldi(4-methylphenyl)phosphine)iminum chloride, Bis(2,4-dimethylbenzyldiphenylphosphine)-iminum chloride, Bis(4-tertbutylbenzyldiphenylphosphine)iminum chloride, Bis(4-

methoxybenzyl diphenylphosphine)iminum chloride, Bis(4-ethoxybenzyl diphenylphosphine)iminum chloride, Bis(4-phenylbenzyl diphenylphosphine)iminum chloride, Bis(4-fluorobenzyl diphenylphosphine)iminum chloride, Bis(4-chlorobenzyl diphenylphosphine)iminum chloride, Bis(4-bromobenzyl diphenylphosphine)iminum chloride, Bis(phenethyl diphenylphosphine)iminum chloride, Bis(diphenylmethyl diphenylphosphine)iminum chloride and Bis(triethyl diphenylphosphine)iminum chloride.

(5) Bis[benzylid(4-methoxyphenyl)phosphine]iminum chloride and Bis[4-methylbenzylid(4-methoxyphenyl)phosphine]iminum chloride.

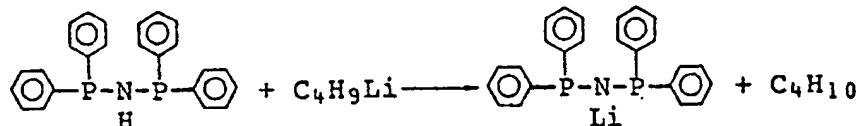
Among these compounds, Bis(benzyl diphenylphosphine)iminum chloride is the most preferable.

The iminium compound (b) is prepared by the similar method described in [Zeitschrift fur Anorganische und Allgemeine Chemie, 492 122 134 (1982)]. If it is necessary to exchange an anion X of the iminium compound (b) from one to another, it may be done by the method described in Acta Chemica Scandinavica, A31 645 (1977) or the usual anion exchange method employing an anion exchange resin.

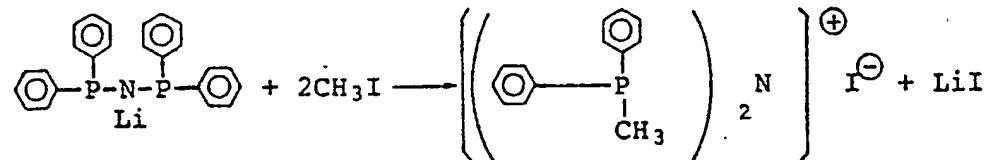
The following are reaction formulae of the representative compounds;

Bis(methyl diphenylphosphine)iminum chloride

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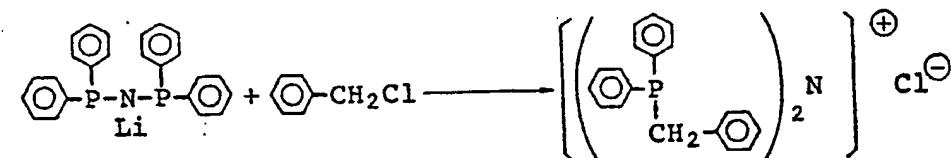
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30 The obtained iminium iodide is changed to the iminium chloride by an anion exchange resin of the chloride type.

Bis(benzylidiphenylphosphine)iminum chloride

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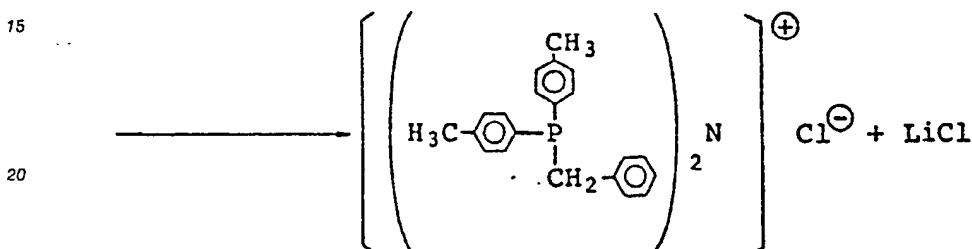
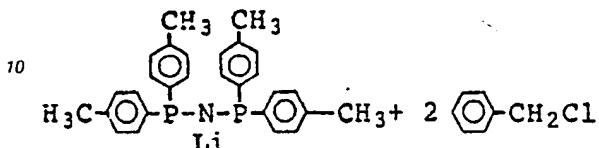
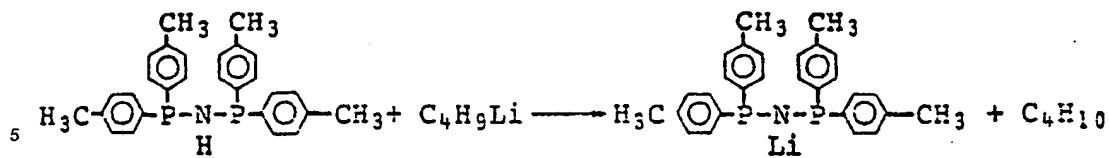
+ LiCl

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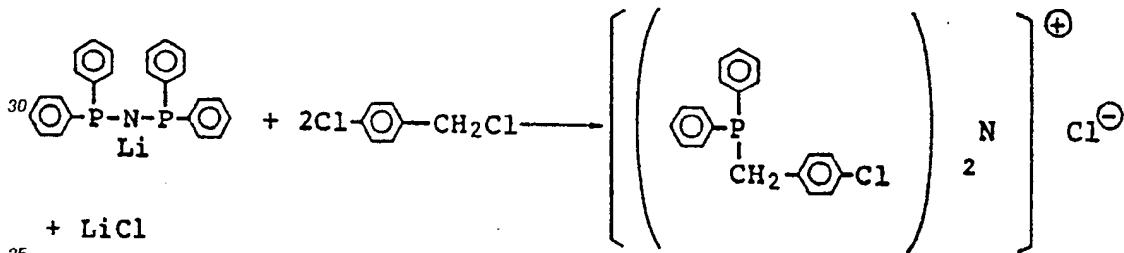
Bis(benzylid(4-methylphenyl)phosphine)iminum chloride

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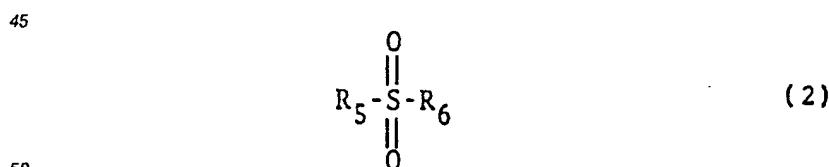
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25 Bis(4-chlorobenzylidiphenylphosphine)iminium chloride



According to the invention, the iminium compound (b) can also be used together with a specific sulfone compound (e) represented by the following formula (2) as an additional curing accelerator of the present fluoroelastomer composition employed in the range of 0.05 to 10 parts by weight to 100 parts by weight of 40 the component (a). The fluoroelastomer composition obtained utilizing this additional curing accelerator shows good processability properties, such as shortened mold time without loss of other properties. Good processability is especially important in the case of molding thick-gage articles. The sulfone compound (e) is represented by the general formula (2):



wherein R_5 and R_6 , the same or different, are substituted or unsubstituted alkyl groups having 1 to 20 carbon atoms, substituted or unsubstituted cycloalkyl groups having 3 to 8 carbon atoms, substituted or 55 unsubstituted cycloalkenyl groups having 4 to 12 carbon atoms, substituted or unsubstituted aralkyl groups having 7 to 20 carbon atoms and substituted or unsubstituted phenyl groups.

Although these compounds are broadly proposed in U.S. Patent 4,287,320, preferable compounds for use according to the present invention are the following:

Those wherein R₅ and R₆, the same or different, may be a C₁-C₈ alkyl, a C₁-C₈ substituted alkyl substituted by a halogen atom, a cyano group or an isocyano group, a C₃-C₈ cycloalkyl, a C₃-C₈ halogenated cycloalkyl, phenyl, a substituted phenyl substituted by halogen or a C₁-C₄ alkyl group, a C₇-C₁₁ aralkyl, a C₇-C₁₁ aralkyl having a substituent of halogen or a C₁-C₄ alkyl group, cycloalkenyl, vinyl and allyl. Among these groups, most preferable is a substituted or unsubstituted alkyl group having 1 to 8 carbon atoms.

Representative compounds are the following:

Dimethylsulfone, Diethylsulfone, Di-n-butyl-sulfone, Di-n-octylsulfone, Bis(2-chloroethyl)sulfone, Ethyl-propylsulfone, Tetramethylenesulfone, 3,4-Dibromotetramethylenesulfone, 3-methylsulfolane, 2,4-dimethylsulfolane, Di-cyclo-hexylsulfone, Diphenylsulfone, Bis(4-fluorophenyl)sulfone, Bis(4-chlorophenyl)sulfone, Bis(4-bromophenyl)sulfone, Bis(4-methylphenyl)sulfone, Dibenzothiphenesulfone, Phenyl-4-methylphenylsulfone, Dibenzylsulfone, Bis(4-methylbenzyl)sulfone, Bis(4-chlorobenzyl)sulfone, Benzyl-4-methylbenzylsulfone, Butadienesulfone, 3-Ethyl-2,5-dihydrothiophene-1,1-dioxide, Methylphenylsulfone, Ethylphenylsulfone, Bis-(phenylsulphonyl)methane, 1,2-Bis(phenylsulphonyl)ethane, 2-Chloroethyl-4-chlorophenylsulfone, Methyl-4-methylphenylsulfone, 2-Chloroethyl-4-methylphenylsulfone, 4-Methylphenylsulfonylacetonitrile, 4-Methylphenyl-sulfonylmethylisocyanide, Benzylmethylsulfone, Benzyl-2-chloroethylsulfone, 4-Methylbenzyl methylsulfone, Benzyl-phenylsulfone, Benzyl-4-methylphenylsulfone, Benzyl-4-chlorophenylsulfone, 4-Methylbenzylphenylsulfone, 4-Chlorobenzylphenylsulfone, 4-Methylbenzyl-4-methylphenylsulfone, phenylvinyl-sulfone, Allylphenylsulfone, 4-Methylphenylvinylsulfone, Allyl-4-chloro-phenylsulfone.

Among these sulfone compounds, dimethylsulfone is the most preferable.

The fluoroelastomer copolymer, the component (a), of the present invention means a copolymer of vinylidene fluoride and at least one other fluorinated monomer. The other fluorinated monomers may be, for example, hexafluoropropene, 1,2,3,3-pentafluoropropene, 3,3,3-trifluoropropene, tetrafluoroethylene, trifluoroethylene, 1,2-difluoroethylene, dichlorodifluoroethylene, chlorotrifluoroethylene, hexafluorobutene, a fluorinated vinylidene, a fluorinated alkyl vinylidene and a perfluoro acrylic acid ester. Among these, preferable monomers are hexafluoropropene, pentafluoropropene and tetrafluoroethylene.

These copolymers are *per se* known in the art as illustrated below and some of these are also available. A copolymer of vinylidene fluoride and hexafluoropropene is disclosed in U.S. Patents 3,051,677, 3,235,537 and 3,318,854 and Japanese Patent Publication No. 7398/1958. A terpolymer of vinylidene fluoride, hexafluoropropene and tetrafluoroethylene is disclosed in U.S. Patent 2,968,649. U.S. Patent 3,801,552 teaches a copolymer of vinylidene fluoride and hexafluoropropene and a terpolymer of vinylidene fluoride, hexafluoropropene and tetrafluoroethylene prepared by the method of a radical suspension polymerization. Copolymers of vinylidene fluoride and another fluorinated monomer such as a fluorinated vinylidene and 1,2,3,3,3-pentafluoro propene are disclosed in U.S. Patents, 3,136,745, 3,331,823 and 3,335,106.

The component (c), a polyhydroxy compound, employed in the present invention as a cross-linking agent is also *per se* well known. A preferable compound is selected from a polyhydroxy aromatic or a fluorinated polyhydroxy aliphatic compound. Examples of the polyhydroxy aromatic compound are Bisphenol A, Bisphenol AF, resorcinol, 1,3,5-trihydroxybenzene, 1,7-, 2,7- or 1,6-dihydroxynaphthalene, 4,4'-dihydroxydiphenyl, 4,4'-di-hydroxystilbene, 2,6-dihydroxyanthracene, hydroquinone, catechol, 2,2-bis(4-hydroxyphenyl)butane, 4,4-bis(4-hydroxyphenyl)pentanoic acid, 2,2-bis(4-hydroxyphenyl)-tetrafluorodichloropropane, 4,4'-dihydroxydiphenylsulfone, 4,4'-dihydroxydiphenylketone, tri(4-hydroxyphenyl)metane, 3,3',5,5'-tetrachlorobisphenol A and 3,3',5,5'-tetrabromobisphenol A. Examples of the fluorinated polyhydroxy aliphatic compound, are

CF₂(CF₂CH₂OH)₂,
HOCH₂(CF₂)₄-OCF(CF₃)CH₂OH,
HOCH₂(CF₂)₂OCF(CF₃)CH₂OH,
CF₂(CFHCF₂CH₂OH)₂,
(CF₂)₃(CF₂CH₂OH)₂,
(CF₂)₃(CFHCF₂CH₂OH)₂,
(CF₂)₅(CF₂CH₂OH)₂ and
(CF₂)₅(CFHCF₂CH₂OH)₂.

Among these, Bisphenol AF and hydroquinone are more preferable. Alkali and alkali earth metal salts of these compounds may also be employed.

The polyhydroxy compound (c) may be also employed as a mixture of the individual compounds described above.

The component (d) is also *per se* known and employed in the art. A preferable compound of a divalent metal oxide or hydroxide may be, for example, an oxide or hydroxide of magnesium, zinc, calcium and

lead, and may be employed together with 1 to 70 weight % of a metal salt of a weak acid. The metal salt may be a stearate, benzoate, carbonate, oxalate or phosphite of a metal such as barium, sodium, potassium, lead and calcium.

5 In the composition of the invention, relating to the amount of the above components to 100 parts by weight of the fluoroelastomeric copolymer (a), 0.05 to 2.0 parts, preferably 0.1 to 1.0 parts of the iminium compound (b), 0.1 to 10 parts, preferably 0.6 to 5.0 parts of the polyhydroxy compound (c) and 1 to 30 parts, preferably 2 to 20 parts of the metal compound (d) are suitably employed. The sulfone compound (e) is employed in the range of 0.05 to 10 parts, preferably 0.1 to 5.0 parts to 100 parts of the component (a).

10 In the present invention, a reinforcing agent, plasticizer, colorant and filler such as carbon black, silica, clay, diatomaceous earth or talc may be added to the composition of the present invention. Moreover one or more conventional curing agents or accelerators may also be added, if desired.

Components (b), (c) and (d) can be mixed with the fluoroelastomer (a) by means of any mixing apparatus known to be useful for preparing fluoroelastomer compositions. In this manner, a master batch of the fluoroelastomer (a) and one or more components (b), (c) and (d) may be applied.

15 The thus obtained fluoroelastomer compositions are cured by a conventional process. For instance, the composition is milled by a roll-type rubber mill or a Banbury mixer, is put into a mold and is cured under pressure followed by a post-curing operation. In general, the press (initial) cure is carried out at 100 to 200 °C, for 3 to 180 minutes and under 20 to 100 bar (kg/cm²), and the post-curing operation is carried out at 150 to 300 °C and for 0 to 30 hours.

20 Other processes which may be carried out for curing include a process in which the curing is carried out after pre-molding or extrusion molding; a process in which a coating composition prepared by dissolving or dispersing the fluoroelastomer composition into a solvent such as ketones, e.g. methylethylketone, acetone, and cyclohexanone, ethers, e.g. methylethylether, diethylether, dioxane and tetrahydrofurane, or a mixture thereof is applied on a surface of paper, fiber, film, sheet, board, tube, pipe, tank, big vessel or 25 other shaped articles and then cured.

The present invention will now be further described by means of specific examples which are not intended to be limitative of the scope of the invention.

30 Reference Example: Preparation of Bis(benzylidiphenyl phosphine)iminum chloride.

To a solution of 3.15 mmol of $[(C_6H_5)_2P]_2NH$ in 30 ml of benzene, is added 3.15 mmol of a butyl lithium-hexane solution diluted by 10 ml of benzene, and the reaction is conducted under reflux for one hour. After the resultant mixture is allowed to cool, a white precipitate is produced by the addition of 6.30 ml 35 of benzylchloride. The solvent is removed by distillation, and the obtained residue is mixed with 35 ml of ethylether followed by reflux under boiling temperature. A white precipitate is filtered and washed two times by 15 ml of ethylether. The precipitate is dissolved into 15 ml of ethanol. The white crystal of Bis(benzylidiphenylphosphine)iminum chloride is produced by the addition of 10 ml of petroleum ether to the ethanol solution. The white crystal is filtered and dried under $1.33 \cdot 10^{-11}$ bar (10^{-8} torr) of vacuum for one 40 night. The yield is 70%. The crystal has a melting point of 255 °C, shows good stability in air and is not hygroscopic and deliquescent.

Example 1

45 One hundred parts by weight of a fluoroelastomeric copolymer Viton E-60 (trade name of E.I. duPont de Nemours & Company, and concerning the copolymers of vinylidene fluoride and hexafluoropropene, having a Mooney ML_{1+10} (100 °C = 60), is milled on a 2-roll mill, while adding 30 parts by weight of M.T. Carbon black, 6 parts by weight of calcium hydroxide, 3 parts by weight of magnesium oxide, Kyowamag #150 50 (sold from Kyowa Chemical Ind. Co., Ltd., Japan), 2.0 parts by weight of Bisphenol AF and 0.34 parts by weight of Bis(methyldiphenylphosphine)iminum chloride prepared by the method described above in the Reference Example, and the resultant composition is allowed to stand over one night. After milling again, the composition is put into a mold and press-cured at 177 °C for 10 minutes to give a sheet and O-ring. The resultant article is removed from the mold and post-cured at 232 °C for 24 hours in an oven in which a 55 blower circulates the air.

The shore hardness (JIS-A), modulus, tensile and elongation values are obtained by JIS K6301. Compression set values are obtained by ASTM D396-61 Method B, using the O-ring having an inside diameter of 23.5 mm and a thickness of 3.5 mm as a test sample, under the conditions of 200 °C, a

compression of 25% and for 72 hours. A curing test is carried out by using an Oscillating Disc Rheometer (Toyo Seiki Seisaku-sho, Ltd., Japan) under the conditions of 177 °C, frequency of 3 cpm and amplitude of 3°.

The results are shown in Table 2.

5

Example 2

The same procedure as in Example 1 is repeated except that 0.45 parts by weight of Bis-(benzyldiphenylphosphine)iminum chloride is employed instead of 0.34 parts by weight of Bis-(methyldiphenylphosphine)iminum chloride. The results are shown in Table 2.

Example 3

15

The same procedure as in Example 1 is repeated except that a fluoroelastomeric terpolymer Viton B (trade name of E.I. duPont de Nemours & Company, and concerning the terpolymer of vinylidene fluoride, hexafluoropropene and tetrafluoroethylene, having a Mooney ML_{1+10} (100 °C) = 75) and 0.90 parts by weight of Bis(benzyldiphenylphosphine)iminum chloride are employed instead of Viton E-60 and 0.34 parts by weight of Bis(methyldiphenylphosphine)iminum chloride, respectively.

The results are shown in Table 2.

Examples 4 to 7 and Comparative Examples 1, 3 and 4

25

The same procedure as in Example 1 is repeated except that instead of the iminium compound of Example 1 the following are employed: Bis[benzyldi(4-methoxyphenyl)phosphine]iminum chloride (Example 4), Bis(2,4-dimethylbenzyldiphenylphosphine)iminum chloride (Example 5), Bis(methyldiphenylphosphine)-iminum tetraborate (Example 6), Bis(benzyldiphenylphosphine)iminum acetate (Example 7) and Bis-(triphenylphosphine)iminum chloride, bromide and iodide (Comparative Examples 1, 3 and 4, respectively). The results are shown in Table 2.

Comparative Example 2

35

The same procedure as in Example 3 is repeated except that Bis(triphenylphosphine)iminum chloride is employed instead of Bis(benzyldiphenylphosphine)iminum chloride. The results are shown in Table 2.

As shown in Examples 1 to 7 and Comparative Examples 1 to 4, the present composition exhibits excellent elongation and a significant advance in the compression set values in comparison with the known 40 composition containing a Bis(triallylphosphine)iminum salt.

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Table 1 (Composition)

| Component (part by weight) | Examples | | | | Comp. Examples | | | | | | |
|--|----------|-----|-----|-----|----------------|------|------|------|------|------|------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 1 | 2 | 3 | 4 |
| Viton E-60 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Viton B | | | | | | | | 100 | 100 | 100 | 100 |
| M.T. carbon black | | | | | | | | 30 | 30 | 30 | 30 |
| Calcium hydroxide | 30 | 30 | 30 | 30 | 30 | 30 | 30 | 6 | 6 | 6 | 6 |
| Magnesium oxide | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 3 | 3 | 3 | 3 |
| Bisphenol AF | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2.0 | 2.0 | 2.0 | 2.0 |
| Bis(methyldiphenylphosphine) iminium chloride | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | | | |
| Bis(benzyldiphenylphosphine) iminium chloride | 0.34 | | | | | | | | | | |
| Bis[benzyldi(4-methoxy phenyl)] phosphine iminium chloride | | | | | 0.90 | | | | | | |
| Bis(2,4-dimethylbenzyldiphenylphosphine) iminium chloride | | | | | | 0.54 | | | | | |
| Bis(methyldiphenylphosphine) iminium tetraborate | | | | | | | 0.47 | | | | |
| Bis(benzyldiphenylphosphine) iminium acetate | | | | | | | | 0.55 | | | |
| Bis(triphenylphosphine) iminium chloride | | | | | | | | | 0.45 | | |
| Bis(triphenylphosphine) iminium bromide | | | | | | | | | | 0.43 | |
| Bis(triphenylphosphine) iminium iodide | | | | | | | | | | | 0.46 |
| | | | | | | | | | | | 0.50 |

Table 2

| Rheometer (177°C) | Examples | | | | Comp. 2 | Examples 3 | 4 |
|---|----------|------|------|------|---------|------------|------|
| | 2 | 3 | 4 | 5 | | | |
| Minimum viscosity (torque) | 2.3 | 2.4 | 5.3 | 2.5 | 2.3 | 2.4 | 2.8 |
| Cure rate (torque) | 45.8 | 43.5 | 43.5 | 44.4 | 41.1 | 43.0 | 46.8 |
| Scorch time (min.) | 5.9 | 5.9 | 7.2 | 6.1 | 5.2 | 7.3 | 5.4 |
| Proper curing time (min.) | 8.3 | 8.4 | 10.4 | 8.0 | 7.6 | 9.2 | 7.2 |
| Tensile Properties | | | | | | | |
| Shore hardness, JIS-A | 75 | 73 | 77 | 74 | 74 | 72 | 77 |
| Modulus at 100% elong. | | | | | | | |
| [kgf/cm ²] bar | 65 | 53 | 69 | 54 | 52 | 68 | 51 |
| Tensile strength [kgf/cm ²] bar | 176 | 169 | 176 | 158 | 171 | 166 | 169 |
| Elongation (%) | 200 | 220 | 230 | 200 | 200 | 180 | 210 |
| Compression set (25.4x3.5mm 0-ring) | | | | | | | |
| 200°C x 72 hours (%) | .. | 20 | 32 | 23 | 25 | 19 | 29 |
| 200°C x 240 hours (%) | - | 30 | - | - | - | 53 | - |

* Press-curing for 15 minutes

Examples 8 to 10

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In order to test the amount of Bisphenol AF, the same procedures as in Example 2 are repeated by employing the various amounts of Bisphenol AF shown in Table 3. The results are shown in Table 3.

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Table 3

| Component | Ex. 8 | Ex. 9 | Ex. 10* |
|--|-------|-------|---------|
| Viton E-60 | 100 | 100 | 100 |
| M.T. carbon black | 30 | 30 | 30 |
| Calcium hydroxide | 6 | 6 | 6 |
| Magnesium oxide | 3 | 3 | 3 |
| Bisphenol AF | 1.5 | 2.5 | 3.5 |
| Bis (benzyl diphenyl) iminium chloride | 0.45 | 0.45 | 0.45 |
| Rheometer (177°C) | | | |
| Minimum viscosity (torque) | 3.0 | 2.0 | 2.2 |
| Cure rate (torque) | 34.2 | 49.3 | 54.9 |
| Scorch time (min.) | 3.4 | 8.4 | 14.2 |
| Proper curing time (min.) | 4.7 | 11.3 | 22.1 |
| Tensile Properties | | | |
| Shore hardness, JIS-A | 68 | 76 | 81 |
| Modulus at 100% elong. [kp/cm^2] bar] | 40 | 66 | 110 |
| Tensile strength [kg/cm^2] bar] | 168 | 179 | 174 |
| Elongation (%) | 280 | 190 | 140 |
| Compression set (25.4x3.5mm O-ring) | | | |
| 200°C x 72 hours (%) | 25 | 18 | 16 |

* Press curing for 20 minutes

Examples 11 to 15

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These examples illustrate compositions containing the sulfone compound.

In Example 11, one part by weight of dimethyl sulfone is added to the composition of Example 2, and then the same procedure as in Example 2 is repeated, except that a press-cure of 5 minutes is used instead of 10 minutes.

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In Example 12, the procedure of Example 11 is repeated by using 3.0 parts by weight of dimethyl sulfone instead of 1.0 part of the sulfone.

In Example 13, the procedure of Example 11 is repeated by using 3.0 parts by weight of dibutyl-sulfone instead of 1.0 part of dimethyl sulfone.

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In Example 14, the same procedure as in Example 11 is used except employing one part of Bis(4-fluorophenyl)-sulfone and 7 minutes of press-curing time.

In Example 15, the same procedure as in Example 11 is used except employing 1.0 part of Bis(4-chlorophenyl)-sulfone and 8 minutes of press-curing time.

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These results are shown in Table 4. As is clear from these examples, it is possible to shorten the time of press-curing without a reduction in the curing properties by further addition of the sulfone compound to the present composition.

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55Table 4

| Composition | Ex. 11 | Ex. 12 | Ex. 13 | Ex. 14 | Ex. 15 | Ex. 2 |
|--|--------|--------|--------|--------|--------|-------|
| Viton E-60 | 100 | 100 | 100 | 100 | 100 | 100 |
| N.T. Carbon black | 30 | 30 | 30 | 30 | 30 | 30 |
| Calcium hydroxide | 6 | 6 | 6 | 6 | 6 | 6 |
| Magnesium oxide | 3 | 3 | 3 | 3 | 3 | 3 |
| Bisphenol AF | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Bis(benzylidiphenylphosphine) imium chloride | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 | 0.45 |
| Dimethyl sulfone | 1.0 | 3.0 | 3.0 | 3.0 | 3.0 | - |
| Dibutyl sulfone | | | | | | - |
| Bis(4-chlorophenyl)sulfone | | | | | | - |
| Bis(4-fluorophenyl)sulfone | | | | | | - |
| Rheometer (177°C) | | | | | | - |
| Minimum viscosity (torque) | 2.5 | 2.8 | 2.1 | 2.4 | 2.3 | 2.4 |
| Cure rate (torque) | 41.1 | 45.6 | 46.0 | 44.6 | 43.7 | 43.5 |
| Scorch time (min.) | 3.8 | 2.2 | 2.8 | 5.1 | 5.5 | 5.9 |
| Proper curing time (min.) | 4.9 | 3.4 | 4.7 | 7.0 | 7.6 | 8.4 |
| Curing condition | | | | | | |
| Press-curing at 177°C (min.) | 5 | 5 | 5 | 7 | 8 | 10 |
| Oven-curing at 232°C x 24 hours | | | | | | |
| Tensile Properties | | | | | | |
| Shore hardness, JIS-A | | | | | | |
| Modulus at 100% elong. [kgf/cm^2] bar] | 74 | 72 | 73 | 73 | 73 | 73 |
| Modulus at 100% elong. [kgf/cm^2] bar] | 61 | 60 | 52 | 55 | 52 | 53 |
| Tensile strength [kgf/cm^2] bar] | 184 | 170 | 180 | 180 | 178 | 169 |
| Elongation (%) | 230 | 210 | 230 | 230 | 220 | 220 |
| Compression set (25.4x3.5mm O-ring:) 200°C x 72 hours (%) | 19 | 20 | 19 | 19 | 20 | 20 |

Examples 16 to 18 and Comparative Examples 5 to 8

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In these Examples, thermal aging tests are conducted in accordance with JIS K6301 on the condition of standing at 200°C for 500 hours. Examples 16 to 18 and Comparative Examples 5 and 6 illustrate the thermal aging tests of the compositions of Examples 2, 11 and 3, Comparative Examples 1 and 2, respectively. In Comparative Example 7 the test is conducted employing the same composition as in Example 1 except 0.60 parts by weight of benzyltriphenylphosphonium chloride instead of 0.34 part by weight of Bis(methyldiphenylphosphine)iminum chloride. In Comparative Example 8, the composition employed is the same as that for Example 3 except that 0.60 parts by weight of Benzyltriphenylphosphonium chloride is used instead of Bis(benzyldiphenylphosphine)iminum chloride, and twenty minutes of press-curing is used instead of the 10 minutes in Example 3.

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The results are shown in Table 5. As is clear from the data in Table 5, the present composition shows excellent thermal resistance as well as the known composition containing benzyltriphenylphosphonium chloride in comparison with the composition containing Bis(triarylphosphine)iminum chloride. There is no influence in the thermal resistance in spite of the presence of the sulfone compound.

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| Component | <u>Ex. 16</u> | <u>Ex. 17</u> | <u>Ex. 18</u> | <u>Comp. Ex. 5</u> | <u>Comp. Ex. 6</u> | <u>Comp. Ex. 7</u> | <u>Comp. Ex. 8</u> |
|-------------------------------|---------------|---------------|---------------|--------------------|--------------------|--------------------|--------------------|
| | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| Viton E-60 | | | | | | | |
| Viton B | 30 | 30 | 30 | 30 | 30 | 30 | 30 |
| M.T. carbon black | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| Calcium hydroxide | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| Magnesium oxide | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| Bisphenol AF | | | | | | | |
| Bis(benzylidiphenylphosphine) | 0.45 | 0.45 | 0.90 | | | | |
| imium chloride | | | | 0.43 | | | |
| Bis(triphenylphosphine) | | | | | 0.86 | | |
| imium chloride | | | | | | 0.60 | |
| Benzyltriphenylyphosphonium | | | | | | | 0.60 |
| chloride | | | | | | | |
| Dimethyl sulfone | | 1.0 | | | | | |
| Aging test (200°C x 500 hrs.) | | | | | | | |
| Variation of hardness (JIS-A) | +1 | +1 | +1 | +1 | +5 | +2 | +1 |
| Variation of modulus at 100% | +15 | +19 | +21 | +45 | +16 | +2 | +2 |
| Variation of tensile strength | +2 | +1 | -28 | -5 | +5 | -6 | -6 |
| Variation of elongation | -2 | -8 | -18 | -31 | -16 | -10 | -10 |

Examples 19 and 20

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These examples illustrate the storage stability of the present compositions. The compositions obtained from the step concerning standing over one night in Examples 2 and 11 are allowed to stand for an additional one week at 40°C and 90% of humidity, and then the same procedures are used with Examples 2 and 11. The results are shown in Table 6 together with the results of Examples 2 and 11. There is no transition in the curing properties, and the present composition shows an excellent storage stability.

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Table 6

| | Ex. 19 | Ex. 20 | Ex. 21 | Ex. 22 |
|---|--------|--------|--------|--------|
| Composition | | | | |
| Viton E-60 | 100 | 100 | 100 | 100 |
| M.T. carbon black | 30 | 30 | 30 | 30 |
| Calcium hydroxide | 6 | 6 | 6 | 6 |
| Magnesium oxide | 3 | 3 | 3 | 3 |
| Bisphenol A | 2.0 | 2.0 | 2.0 | 2.0 |
| Bis(benzylidiphenylphosphine)iminium chloride | 0.45 | 0.45 | 0.45 | 0.45 |
| Dimethyl sulfoxide | | | | 1.0 |
| Rheometer (177°C) | | | | |
| Minimum viscosity (torque) | 3.1 | 2.4 | 3.4 | 2.5 |
| Cure rate (torque) | 40.6 | 43.5 | 39.6 | 41.1 |
| Scorch time (min.) | 3.4 | 5.9 | 2.9 | 3.8 |
| Proper curing time (min.) | 5.7 | 8.4 | 4.0 | 4.9 |
| Curing condition | | | | |
| Press-curing at 177°C (min.) | 10 | 10 | 5 | 5 |
| Oven-curing at 232°C x 24 hours | | | | |
| Tensile Properties | | | | |
| Shore hardness, JIS-A | 73 | 73 | 73 | 74 |
| Modulus at 100% elong. [kgf/cm^2] bar] | 53 | 53 | 64 | 61 |
| Tensile strength [kgf/cm^2] bar] | 170 | 169 | 187 | 184 |
| Elongation (%) | 220 | 220 | 240 | 230 |
| Compression set (25.4x3.5mm O-ring) | | | | |
| 200°C x 72 hours (%) | 19 | 20 | 19 | 19 |

Example 21 and Comparative Example 9

A mold releasing property is tested in these Examples. The same procedure as in Example 1 is repeated except that 0.15 parts by weight of Bis(benzylidiphenylphosphine)iminium chloride is used instead

of 0.34 parts of Bis(methyldiphenylphosphine) iminium chloride and 60 minutes of press-curing is employed instead of 10 minutes (Example 21). In order to make a comparison, the procedure of Example 21 is repeated by using 0.11 parts by weight of the known benzyltriphenylphosphonium chloride instead of 0.15 parts of Bis(benzylidiphenylphosphine)iminum chloride. The results are shown in Table 7. The present composition is superior in the mold releasing property to the composition containing the known benzyltriphenylphosphonium chloride.

Table 7

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| Composition | Ex. 21 | Comp. Ex. 9 |
|--|--------|-------------|
| Viton E-60 | 100 | 100 |
| M.T. carbon black | 30 | 30 |
| Calcium hydroxide | 6 | 6 |
| Magnesium oxide | 3 | 3 |
| Bisphenol AF | 2.0 | 2.0 |
| Bis(benzylidiphenylphosphine) iminium chloride | 0.15 | |
| Benzyltriphenylphosphonium chloride | | 0.11 |

Rheometer (177°C)

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| | | |
|----------------------------|------|------|
| Minimum viscosity (torque) | 2.6 | 2.6 |
| Cure rate (torque) | 47.4 | 43.9 |
| Scorch time (min.) | 33.0 | 24.5 |
| Proper curing time (min.) | 56.9 | 46.8 |

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Curing condition

| | | |
|------------------------------|----|----|
| Press-curing at 177°C (min.) | 60 | 60 |
| Oven-curing 232°C x 24 hrs. | | |

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Tensile properties

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| | | |
|---|-----|-----|
| Shore hardness, JIS-A | 74 | 71 |
| Modulus at 100% elongn. [(kgf/cm ²) bar] | 51 | 50 |
| Tensile strength [(kgf/cm ²) bar] | 186 | 165 |
| Elongation (%) | 230 | 200 |

45

Compression set (25.4x3.5mm O-ring)

| | | |
|----------------------|----|----|
| 200°C x 72 hours (%) | 17 | 17 |
|----------------------|----|----|

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Processibility of O-ring (Press-curing
at 177°C x 60 min.)

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| | | |
|--|----|----|
| Appearance rate of blister and blemish induced by the adhesion of the cured elastomer to the mold | 11 | 82 |
|--|----|----|

Examples 22 and 23, and Comparative Examples 10 and 11

The similar procedures of Example 2 are repeated by using another fluoroelastomeric copolymer Tecnoflone NML and Tecnoflone NM (trade name of Montedison S.P.A.; a copolymer of vinylidene fluoride and hexafluoropropene and having a Mooney ML_{1+4} (100 °C) = 55 and 85, respectively). The amount of each component and curing conditions are shown in Table 8 together with their results.

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Table 8

| | Component | Ex. 22 | Ex. 23 | Comp. Ex. 10 | Comp. Ex. 11 |
|----|---|--------|--------|--------------|--------------|
| 5 | Tecnoflone NML | 100 | | 100 | |
| | Tecnoflone NM | | 100 | | 100 |
| 10 | M.T. carbon black | 25 | 25 | 25 | 25 |
| | Calcium hydroxide | 5 | 5 | 5 | 5 |
| | Magnesium oxide | 5 | 5 | 5 | 5 |
| | Bisphenol AF | 2.0 | 2.0 | 1.8 | 1.7 |
| 15 | Bis(benzylidiphenyl phosphine)iminum chloride | 0.45 | 0.45 | | |
| | Bis(triphenylphosphine)iminum chloride | | | 0.60 | |
| 20 | Bis(triphenylphosphine)iminum bromide | | | | 0.65 |
| | Rheometer (177°C) | | | | |
| 25 | Minimum viscosity (torque) | 3.2 | 5.6 | 3.8 | 4.9 |
| | Curing rate (torque) | 42.3 | 42.9 | 46.1 | 44.9 |
| | Scorch time (min.) | 7.5 | 7.0 | 3.3 | 3.4 |
| 30 | Proper curing time (min.) | 13.3 | 11.3 | 5.8 | 6.1 |
| | Curing condition | | | | |
| 35 | Press-curing at 177°C (min.) | 20 | 20 | 10 | 10 |
| | Oven curing 232°C x 24 hrs. | | | | |
| 40 | Tensile properties | | | | |
| | Shore hardness, JIS-A | 71 | 69 | 74 | 71 |
| | Modulus at 100% elongn. [(kgf/cm²) bar] | 59 | 56 | 73 | 58 |
| 45 | Tensile strength [(kgf/cm²) bar] | 195 | 192 | 179 | 178 |
| | Elongation (%) | 200 | 200 | 160 | 180 |
| | Compression set (25.4 x 3.5mm O-ring) | | | | |
| 50 | 200°C x 72 hours (%) | 21 | 20 | 31 | 32 |

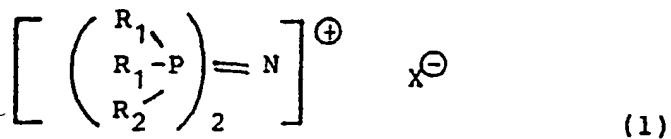
55 The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. A curable fluoroelastomer composition comprising

5 (a) 100 parts by weight of a fluoroelastomeric copolymer of vinylidene fluoride and at least one other fluorinated monomer,

(b) 0.05 to 2.0 parts by weight of a curing accelerator comprising an iminium compound represented by the formula (1)



15 wherein R_1 is an aryl group or a substituted aryl group substituted by at least one member selected from the group consisting of an alkyl group having 1 to 20 carbon atoms, an alkoxy group having 1 to 20 carbon atoms, a cyano group, a cycloalkyl group having 3 to 8 carbon atoms, a group of the formula



25 wherein R_3 and R_4 , the same or different, are each C_1-C_{20} alkyl, C_3-C_8 cycloalkyl or a phenyl group, and a halogen atom,

30 R_2 is an alkyl or halogenated alkyl group having 1 to 20 carbon atoms, a cycloalkyl or halogenated cycloalkyl group having 3 to 8 carbon atoms, an aralkyl group having 7 to 20 carbon atoms, or a substituted aralkyl group having an aralkyl skeleton of 7 to 20 carbon atoms in which at least one hydrogen atom of the aryl part is substituted by at least one member selected from the group consisting of a C_1-C_{20} alkyl group, a C_3-C_8 cycloalkyl group, a C_1-C_{20} alkoxy group, a phenyl group, a cyano group, a group of the formula



40 wherein R_3 and R_4 , the same or different, are each C_1-C_{20} alkyl, C_3-C_8 cycloalkyl or a phenyl group, and a halogen atom,

45 X is halogen, hydroxyl, sulfate, thiosulfate, nitrate, formate, acetate, cyanate, thiocyanate, tetraphenylborate, 2-mercaptopbenzothiazolate, or perchlorate ion;

(c) 0.1 to 10 parts by weight of a polyhydroxy compound as a cross-linking agent; and

(d) 1 to 30 parts by weight of a metal compound selected from a divalent metal hydroxide, a divalent metal oxide or a mixture thereof.

50 2. A curable fluoroelastomer composition according to claim 1, wherein R_1 is an unsubstituted phenyl group.

3. A curable fluoroelastomer composition according to claim 1, wherein R_1 is a substituted phenyl group.

55 4. A curable fluoroelastomer composition according to any of the claims 1 to 3, wherein R_2 is an aralkyl group having 7 to 20 carbon atoms.

5. A curable fluoroelastomer composition according to claim 1, wherein R_2 is an alkyl group having 1 to 20 carbon atoms.

6. A curable fluoroelastomer composition according to claim 1, wherein R_1 is an unsubstituted or substituted phenyl group and R_2 is a substituted or unsubstituted benzyl group.

7. A curable fluoroelastomer composition according to claim 6, wherein R₁ is an unsubstituted phenyl group.

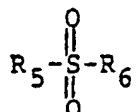
8. A curable fluoroelastomer composition according to claim 6, wherein R₂ is an unsubstituted benzyl group.

9. A curable fluoroelastomer composition according to claim 1, wherein R₁ is an unsubstituted phenyl group and R₂ is an unsubstituted benzyl group.

10. A curable fluoroelastomer composition according to any of the claims 1 to 9, wherein X is a chloride or bromide ion.

11. A curable fluoroelastomer composition according to any of the claims 1 to 10, further comprising 0.05 to 10 parts by weight of a sulfone compound, as a curing accelerator, represented by the formula :

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(2)

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wherein R₅ and R₆, the same or different, are each a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms, a substituted or unsubstituted cycloalkenyl group having 4 to 12 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms and a substituted or unsubstituted phenyl group.

12. A curable fluoroelastomer composition according to claim 11, wherein R₅ and R₆ are substituted or unsubstituted alkyl groups having 1 to 8 carbon atoms.

13. A curable fluoroelastomer composition according to any of the claims 1 to 12, wherein said iminium compound is bis(benzyldiphenylphosphine)iminium chloride.

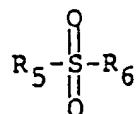
14. A curable fluoroelastomer composition according to claim 11 or 13, wherein said sulfone compound is dimethylsulfone.

15. A curable fluoroelastomer composition according to any of the claims 1 to 14, wherein said polyhydroxy compound is bisphenol AF or hydroquinone.

16. A curable fluoroelastomer composition according to claim 1, wherein said iminium compound is bis(benzyldiphenylphosphine) iminium chloride, said polyhydroxy compound is bisphenol AF or hydroquinone, and said metal compound is an oxide or hydroxide of magnesium, zinc, calcium or lead.

17. A curable fluoroelastomer composition according any of the claims 1, 9 and 16 further comprising a sulfone compound as a curing accelerator, represented by the formula :

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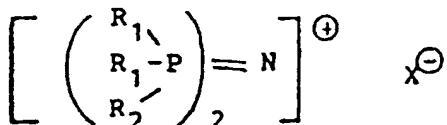
(2)

wherein R₅ and R₆, the same or different, are each a substituted or unsubstituted alkyl group having 1 to 20 carbon atoms, a substituted or unsubstituted cycloalkyl group having 3 to 20 carbon atoms, a substituted or unsubstituted cycloalkenyl group having 4 to 12 carbon atoms, a substituted or unsubstituted aralkyl group having 7 to 20 carbon atoms and a substituted or unsubstituted phenyl group.

18. A curable fluoroelastomer composition according to claim 16 or 17, further comprising 0.05 to 10 parts by weight of dimethylsulfone.

5 Revendications

1. Composition durcissable à base d'un élastomère fluoré, comprenant
 (a) 100 parties en poids d'un copolymère élastomère fluoré de fluorure de vinylidène et d'au moins un autre monomère fluoré,
 10 (b) de 0,05 à 2,0 parties en poids d'un accélérateur de durcissement comprenant un composé iminium de formule (1)



20 dans laquelle R_1 est un groupe aryle ou un groupe aryle substitué par au moins un élément choisi parmi le groupe consistant en un groupe alcoyle ayant de 1 à 20 atomes de carbone, un groupe alcoxy ayant de 1 à 20 atomes de carbone, un groupe cyano, un groupe cycloalcoyle ayant de 3 à 8 atomes de carbone, un groupe de formule



30 dans laquelle R_3 et R_4 , qui sont identiques ou différents, sont chacun un groupe alcoyle ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle ayant de 3 à 8 atomes de carbone ou un groupe phényle, et un atome d'halogène,

35 R_2 est un groupe alcoyle ou un groupe alcoyle halogéné ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle ou un groupe cycloalcoyle halogéné ayant de 3 à 8 atomes de carbone, un groupe aralcoyle ayant de 7 à 20 atomes de carbone ou un groupe aralcoyle substitué ayant un squelette d'aralcoyle de 7 à 20 atomes de carbone, dont l'un au moins des atomes d'hydrogène de la partie aryle est remplacé par au moins un élément choisi dans le groupe consistant en un groupe alcoyle ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle ayant de 3 à 8 atomes de carbone, un groupe alcoxy ayant de 1 à 20 atomes de carbone, un groupe phényle, un groupe cyano, un groupe de formule



45 dans laquelle R_3 et R_4 , qui sont identiques ou différents, sont chacun un groupe alcoyle ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle ayant de 3 à 8 atomes de carbone ou un groupe phényle, et un atome d'halogène,

50 X est un halogène, un hydroxyle, un ion sulfate, un ion thiosulfate, un ion nitrate, un ion formiate, un ion acétate, un ion cyanate, un ion thiocyanate, un ion téraphénylborate, un ion 2-mercaptopbenzothiazolate, ou un ion perchlorate ;

(c) de 0,1 à 10 parties en poids d'un composé polyhydroxylé comme agent de réticulation ; et
 (d) de 1 à 30 parties en poids d'un composé métallique choisi parmi un hydroxyde métallique divalent, un oxyde métallique divalent ou un mélange de ceux-ci.

55 2. Composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle R_1 est un groupe phényle non substitué.

3. composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle R_1 est

un groupe phényle substitué.

4. Composition durcissable à base d'un élastomère fluoré suivant l'une des revendications 1 à 3, dans laquelle R₂ est un groupe aralcoyle ayant de 7 à 20 atomes de carbone.

5. Composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle R₂ est un groupe alcoyle ayant de 1 à 20 atomes de carbone.

10. Composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle R₁ est un groupe phényle non substitué ou substitué et R₂ est un groupe benzyle substitué ou non substitué.

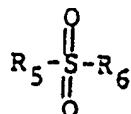
15. 7. composition durcissable à base d'un élastomère fluoré suivant la revendication 6, dans laquelle R₁ est un groupe phényle non substitué.

15. 8. Composition durcissable à base d'un élastomère fluoré suivant la revendication 6, dans laquelle R₂ est un groupe benzyle non substitué.

15. 9. Composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle R₁ est un groupe phényle non substitué et R₂ est un groupe benzyle non substitué.

20. 10. Composition durcissable à base d'un élastomère fluoré suivant l'une quelconque des revendications 1 à 9, dans laquelle X est un ion chlorure ou un ion bromure.

25. 11. Composition durcissable à base d'un élastomère fluoré suivant l'une quelconque des revendications 1 à 10, comprenant en outre de 0,05 à 10 parties en poids d'une sulfone, servant d'accélérateur de durcissement, de formule



35. dans laquelle R₅ et R₆, qui sont identiques ou différents, sont chacun un groupe alcoyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe cycloalcényle ayant de 4 à 12 atomes de carbone, un groupe aralcoyle substitué ou non substitué ayant de 7 à 20 atomes de carbone ou un groupe phényle substitué ou non substitué.

40. 12. Composition durcissable à base d'un élastomère fluoré suivant la revendication 11, dans laquelle R₅ et R₆ sont des groupes alcoyle substitués ou non substitués ayant de 1 à 8 atomes de carbone.

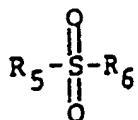
45. 13. Composition durcissable à base d'un élastomère fluoré suivant l'une quelconque des revendications 1 à 12, dans laquelle le composé iminium est le chlorure de bis(benzylidiphénylphosphine)iminium.

45. 14. Composition durcissable à base d'un élastomère fluoré suivant la revendication 11 ou 13, dans laquelle la sulfone est la diméthylsulfone.

50. 15. Composition durcissable à base d'un élastomère fluoré suivant l'une quelconque des revendications 1 à 14, dans laquelle le composé polyhydroxylé est le bisphénol AF ou l'hydroquinone.

55. 16. Composition durcissable à base d'un élastomère fluoré suivant la revendication 1, dans laquelle le composé iminium est le chlorure de bis(benzylidiphénylphosphine)iminium, le composé polyhydroxylé est le bisphénol AF ou l'hydroquinone, et le composé métallique est un oxyde ou un hydroxyde de magnésium, de zinc, de calcium ou de plomb.

55. 17. Composition durcissable à base d'un élastomère fluoré suivant l'une quelconque des revendications 1, 9 ou 16, comprenant en outre une sulfone comme accélérateur de vulcanisation, de formule :



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10 dans laquelle R_5 et R_6 , qui sont identiques ou différents, sont chacun un groupe alcoyle substitué ou non substitué ayant de 1 à 20 atomes de carbone, un groupe cycloalcoyle substitué ou non substitué ayant de 3 à 20 atomes de carbone, un groupe cycloalcényle ayant de 4 à 12 atomes de carbone, un groupe aralcoyle substitué ou non substitué ayant de 7 à 20 atomes de carbone ou un groupe phényle substitué ou non substitué.

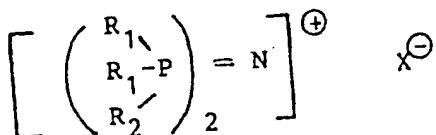
15 18. Composition durcissable à base d'un élastomère fluoré suivant l'une des revendications 16 ou 17, comprenant en outre de 0,05 à 10 parties en poids de diméthylsulfone.

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Ansprüche

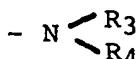
20 1. Eine härtbare Fluorelastomerzusammensetzung, die enthält
 a) 100 Gewichtsteile eines Fluorelastomer-Copolymers aus Vinylidenfluorid und mindestens einem anderen fluorierten Monomer,
 b) 0,05 bis 2 Gewichtsteile eines Härtungsbeschleunigers, der eine Iminiumverbindung, die durch die Formel (1) dargestellt wird, umfasst

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35 in welcher R_1 eine Arylgruppe oder eine substituierte Arylgruppe ist, die mit mindestens einem aus der Gruppe ausgewählten Mitglied substituiert ist, die aus einer Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, einer Alkoxygruppe mit 1 bis 20 Kohlenstoffatomen, einer Cyangruppe, einer Cycloalkylgruppe mit 3 bis 8 Kohlenstoffatomen, einer Gruppe der Formel



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45 in welcher R_3 und R_4 , gleich oder unterschiedlich, jeweils $\text{C}_1\text{-C}_{20}\text{-Alkyl}$, $\text{C}_3\text{-C}_8\text{-Cycloalkyl}$ oder eine Phenylgruppe sind, und einem Halogenatom besteht, R_2 eine Alkyl- oder halogenierte Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, eine cycloalkyl- oder halogenierte Cycloalkylgruppe mit 3 bis 8 Kohlenstoffatomen, eine Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen oder eine substituierte Aralkylgruppe mit einem Aralkylskelett von 7 bis 20 Kohlenstoffatomen ist, in der mindestens ein Wasserstoffatom des Arylteils durch mindestens ein aus der Gruppe ausgewähltes Mitglied substituiert ist, die aus einer $\text{C}_1\text{-C}_{20}\text{-Alkylgruppe}$, einer $\text{C}_3\text{-C}_8\text{-Cycloalkylgruppe}$, einer $\text{C}_1\text{-C}_{20}\text{-Alkoxygruppe}$, einer Phenylgruppe, einer Cyangruppe, einer Gruppe der Formel -

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55 in welcher R_3 und R_4 , gleich oder unterschiedlich, jeweils $\text{C}_1\text{-C}_{20}\text{ Alkyl}$, $\text{C}_3\text{-C}_8\text{-Cycloalkyl}$ oder eine Phenylgruppe sind, und einem Halogenatom besteht,

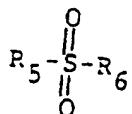
X ein Halogen-, Hydroxyl-, Sulfat-, Thiosulfat-, Nitrat-, Formiat-, Acetat-, Cyanat-, Thiocyanat-, Tetraphenylborat-, 2-Mercaptobenzothiazolat oder Perchloration ist;

c) 0,1 bis 10 Gewichtsteile einer Polyhydroxyverbindung als Vernetzungsmittel; und

d) 1 bis 30 Gewichtsteile einer Metallverbindung, ausgewählt unter einem Hydroxid eines divalenten

Metalls, einem Oxid eines divalenten Metalls oder einer Mischung davon.

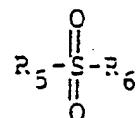
2. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher R₁ eine unsubstituierte Phenylgruppe ist.
- 5 3. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher R₁ eine substituierte Phenylgruppe ist.
- 10 4. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1 bis 3, in welcher R₂ eine Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen ist.
- 15 5. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher R₂ eine Alkylgruppe mit 1 bis 20 Kohlenstoffatomen ist.
6. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher R₁ eine unsubstituierte oder substituierte Phenylgruppe ist und R₂ eine substituierte oder unsubstituierte Benzylgruppe ist.
- 20 7. Härtbare Fluorelastomerzusammensetzung nach Anspruch 6, in welcher R₁ eine unsubstituierte Phenylgruppe ist.
8. Härtbare Fluorelastomerzusammensetzung nach Anspruch 6, in welcher R₂ eine unsubstituierte Benzylgruppe ist.
- 25 9. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher R₁ eine unsubstituierte Phenylgruppe ist und R₂ eine unsubstituierte Benzylgruppe ist.
10. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1 bis 9, in welcher X ein Chlorid- oder Bromidion ist.
- 30 11. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1 bis 10, die zusätzlich 0,05 bis 10 Gewichtsteile einer Sulfonverbindung als einen Härtungsbeschleuniger enthält, repräsentiert durch die Formel:



- 40 in welcher R₅ und R₆, gleich oder unterschiedlich, jeweils eine substituierte oder unsubstituierte Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, eine substituierte oder unsubstituierte Cycloalkylgruppe mit 3 bis 20 Kohlenstoffatomen, eine substituierte oder unsubstituierte Cycloalkenylgruppe mit 4 bis 12 Kohlenstoffatomen, eine substituierte oder unsubstituierte Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen und eine substituierte oder unsubstituierte Phenylgruppe sind.
- 45 12. Härtbare Fluorelastomerzusammensetzung nach Anspruch 11, in welcher R₅ und R₆ substituierte oder unsubstituierte Alkylgruppen mit 1 bis 8 Kohlenstoffatomen sind.
- 50 13. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1 bis 12, in welcher die Iminiumverbindung Bis-(benzylidiphenylphosphin)-iminiumchlorid ist.
14. Härtbare Fluorelastomerzusammensetzung nach Anspruch 11 oder 13, in welcher die Sulfonverbindung Dimethylsulfon ist.
- 55 15. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1 bis 14, in welcher die Polyhydroxyverbindung Bisphenol AF oder Hydrochinon ist.

16. Härtbare Fluorelastomerzusammensetzung nach Anspruch 1, in welcher die Iminiumverbindung Bis-(benzylidiphenylphosphin)-iminiumchlorid, die Polyhydroxyverbindung Bisphenol AF oder Hydrochinon und die Metallverbindung ein Oxid oder Hydroxid von Magnesium, Zink, Calcium oder Blei ist.

5 17. Härtbare Fluorelastomerzusammensetzung nach einem der Ansprüche 1, 9 und 16, die zusätzlich eine Sulfonverbindung als Härtungsbeschleuniger enthält, repräsentiert durch die Formel:



15 in welcher R_5 und R_6 , gleich oder unterschiedlich, jeweils eine substituierte oder unsubstituierte Alkylgruppe mit 1 bis 20 Kohlenstoffatomen, eine substituierte oder unsubstituierte Cycloalkylgruppe mit 3 bis 20 Kohlenstoffatomen, eine substituierte oder unsubstituierte Cycloalkenylgruppe mit 4 bis 12 Kohlenstoffatomen, eine substituierte oder unsubstituierte Aralkylgruppe mit 7 bis 20 Kohlenstoffatomen und eine substituierte oder unsubstituierte Phenylgruppe ist.

20 18. Härtbare Fluorelastomerzusammensetzung nach Anspruch 16 oder 17, die zusätzlich 0,05 bis 10 Gewichtsteile Dimethylsulfon enthält.

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